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APPARATUS AND METHOD FOR FURNISHING AN OPERATING PRESSURE IN A FLUID

[0001] Prior Art

[0002] The invention relates to an apparatus for furnishing a working pressure in a fluid, having a first region in which a first pressure prevails that is higher than the working pressure, a second region in which the working pressure is to be furnished, and means for reducing the first pressure in the first region to the working pressure in the second region, which means are disposed between the first region and the second region. The invention also relates to a method for furnishing a working pressure in a fluid, in which fluid from a first region at high pressure is transferred to a second region at lower pressure, and the pressure of the fluid is reduced to a working pressure in the second region.

[0003] An apparatus and a method of this generic type are used for instance in reservoir-type injection systems for Diesel engines. In reservoir injection or common rail injection, the pressure generation and injection are decoupled from one another. The injection pressure, for instance of 200 to 1800 bar, is generated independently of the engine speed and of the injection quantity and is available for the injection in the rail or fuel reservoir.

[0004] For the sake of injection, accordingly a very high pressure must be transmitted from the common rail into the injector. To assure the general function of the injector, a working pressure is required in the injector, for instance of 30 bar. It also makes sense to make this pressure available using the common rail pressure, since in this way additional pressure generating means and pressure reservoirs can be dispensed with.

[0005] Fig. 1 schematically shows a design for furnishing an working pressure in an injector. This design can be used both to explain the invention per se and, at this point in the description, to explain the prior art. In a first region 10, the pressure of the common rail prevails, while in a second region 12, the working pressure for the injector is to be made available. The first region 10 and the second region 12 communicate with one another via a piston 14. The pressure buildup in the second region 12 and thus in the injector takes place via the gap flow of the piston 14. To adjust the working pressure in the second region 12 to the correct value, in the prior art a pressure-holding valve 16 is provided, which adjusts the pressure. As soon as the working pressure and the second region 12 exceeds a rated pressure, the pressure-holding valve 16 opens and finally blows the requisite quantity of fluid as a leakage quantity into the fuel tank, until the working pressure in the second region 12 is reached again. The pressure-holding valve 16 then closes.

[0006] In the prior art, regulating the working pressure is accordingly done at the cost of a relatively large leakage quantity. The affect of the undesired large leakage quantity is further reinforced by the fact that the pressure in the common rail is not constant over the various operating states. On the contrary, the pressure can vary within a range from 200 to 1800 bar. Consequently at high pressure, a substantially larger fluid quantity will flow out of the first region 10 into the second region 12 via the inflow piston 14 than at the low common rail pressure. For this reason, precisely at a high common rail pressure, a considerable pressure compensation via the pressure-holding valve 16 is required, which entails a large leakage quantity.

[0007] In other words, if the gap of the piston 14 is dimensioned such that at the comparatively low common rail pressure in the first region 10 an adequate working pressure is generated in the second region 12, then necessarily a very much higher pressure occurs in the second region 12 when a high common rail pressure prevails in the first region 10. This elevated pressure in the second region 12 must be dissipated by diverting a leakage quantity via the pressure-holding valve 16.

[0008] Fig. 3 shows an arrangement in the prior art, with an inflow piston 114 - corresponding to the inflow piston 14 of Fig. 1 - that is disposed between a first region 110 - corresponding to the region 10 of Fig. 1 - and a second region 112 - corresponding to the region 12 of Fig. 1. Common rail pressure prevails in the first region 110, while a working pressure is to be established in the second region 112. Because of the constant gap width between the inflow piston 114 and the bore 118, in which bore the inflow piston 114 is placed, the aforementioned problems of an excessive leakage quantity occur at high common rail pressures.

[0009] Advantages of the Invention

[0010] The apparatus of the invention builds on the prior art in an advantageous way by providing that the means for reduction can be influenced by the pressure difference between the first region and the second region, so that at a great pressure difference between the first region and the second region, a greater reduction occurs than at a low pressure difference between the first region and the second region. The apparatus thus on the one hand assures that at low common rail pressure, an adequate working pressure will be available in the injector. On the other hand, the means for reducing the pressure are influenced by the pressure difference in such a way that at a high common rail pressure, a greater reduction in the pressure takes place at the transition of fluid

from the first region to the second region. It is therefore no longer necessary for the working pressure in the second region to be adjusted solely by the use of a pressure-holding valve. Consequently the resultant leakage quantity is reduced considerably. It should be noted as a precaution at this point that while the explanation of the invention is always made in the context of motor vehicle components, this is not a limitation to the range of uses of the invention. Other areas in which it can be used are noted below.

[0011] Preferably, the means for reduction include a bore having a structure varying in the longitudinal direction, and a piston, which is displaceable in the longitudinal direction in the bore as a function of the pressure difference existing between the first region and the second region, so that the resistance to the fluid varies depending on the piston position. In the above-described prior art, a solid inflow piston was used. Consequently, regardless of the pressure in the first region and the second region, the same inflow gap always existed, which led to an undesired increase in pressure in the second region at a high common rail pressure. This could be reduced only by diverting the fluid into a leakage line. The invention now advantageously utilizes the change in pressure in the first region, even though that is initially problematic with a view to the most constant possible working pressure in the injector. However, by providing that the pressure difference displaces the piston in precisely such a way that the overflow of the fluid is regulated, the furnishing of a virtually constant working pressure in the injector, regardless of the current common rail pressure, is achieved.

[0012] Preferably, the bore has a first portion and a second portion, and the resistance to the fluid is greater the farther the piston penetrates into the second portion. That is, if the piston is forced by an increasing common rail pressure in the first region increasingly from the first portion of the bore into the second portion of the bore, then the resistance to the overflowing fluid increases more and more. The result is a regulation of the pressure in the second region. With suitable dimensioning, a virtually constant working pressure can accordingly be achieved over the entire pressure range of the common rail.

[0013] Advantageously, the piston is guided over its entire displacement path by the bore. For instance, if the bore is designed such that it has a first portion and a second portion that in cooperation with the piston present various resistances to the fluid, then these portions are advantageously both nevertheless designed in such a way that they guide the piston over its entire displacement path. This makes for reliable, malfunction-free pressure regulation.

[0014] Preferably, elastic means are provided, which subjects the piston in the longitudinal direction to force that acts in the direction of the first region. The elastic force thus counteracts the high pressure in the first region. With increasing pressure in the first region, the piston is forced in the direction of the second region, counter to the elastic force. Given suitable structuring of the bore, the resistance to the fluid can accordingly be regulated in a reliable way. The prestressing of the piston also assures reliable function.

[0015] It is preferable that the elastic means exert a pressure force on the piston that acts in the direction of the first region. Thus the elastic means can be disposed in the second region, which can be especially advantageous because of the lower pressure and the lesser pressure fluctuations in the second region.

[0016] Preferably, the elastic means include at least one spring, which subjects the piston to force on the side of the second region. This is an especially simple, effective realization of the elastic counterforce, compared to the common rail pressure in the first region.

[0017] Preferably, the pressure in the first region is between about 200 and 1800 bar. With the invention, it is possible to adjust a virtually constant working pressure in the second region, even though a pressure change of virtually one order of magnitude occurs in the first region.

[0018] Preferably, the working pressure in the second region amounts to about 30 bar. This is a useful working pressure for modern injector systems.

[0019] It can be advantageous if a pressure-holding valve is provided in the second region. With this kind of pressure- holding valve, the entire adjustment of the working pressure was achieved in the prior art systems simply by tolerating a large leakage quantity. With the present invention it is no longer necessary to generate such a large leakage quantity. At the same time, a pressure-holding valve can still be provided for the sake of further regulation or for fine- tuning of the working pressure.

[0020] Advantageously, in the first region, the pressure of a common rail prevails. In common rail injection systems, the invention proves to be especially advantageous, since intrinsically a high pressure exists in the common rail, and this high pressure varies depending on the operating state. The generation of lower pressures on the basis of the invention is accordingly advantageous.

[0021] In this connection it is preferred that the second region is the operating region of an injector. Injectors of injection systems, specifically, require a working pressure that is feasible with the present invention if they are to function reliably.

[0022] The invention is especially advantageous if the injector is a piezoelectric injector. Piezoelectric injectors are devices with an adjusting valve that is triggered by a piezoelectric element. Reliably furnishing a working pressure in such a piezoelectric injector while at the same time avoiding large leakage quantities is a fundamental goal that is reached by the present invention.

[0023] The method of the invention advantageously builds on the prior art by providing that the reduction of the pressure is controlled by the pressure difference between the first region and the second region, so that the pressure is reduced all the more, the greater the pressure difference between the first region and the second region is. The method according to the invention thus puts the advantages of the apparatus of the invention to use.

[0024] Preferably, by the variation in the pressure difference, a piston is displaced that is guided in a bore, and the resistance to the fluid is varied by the displacement of the piston. A regulating method for furnishing a virtually constant working pressure is thus available.

[0025] However, it can nevertheless be useful that an elevated working pressure is compensated for by a pressure- holding valve. This can be a useful additional provision for adjusting the working pressure.

[0026] The invention is based on the surprising recognition that by simple means, the pressure difference between two separate regions can be used as a controlled variable, in order to generate a virtually constant pressure in one of the regions while in another region pressure changes of up to one order of magnitude occur. The invention thus on the one hand makes good function of a common rail injection system available, and under some circumstances it is even possible to dispense with a pressure-holding valve at the injector. On the other hand, the leakage quantity of the system is advantageously reduced. Even though the invention has been explained primarily in conjunction with a common rail injection system, it is advantageously also usable in other areas, for instance in pumps. In common rail systems, the Diesel fuel is the pressure-regulated fluid; in other systems, the most various fluids can be used in which a certain pressure is furnished on the basis of the present invention.

[0027] Drawing

[0028] The invention will now be explained taking preferred embodiments as an example in conjunction with the accompanying drawing.

[0029] Fig. 1 is a highly schematic illustration of an apparatus, for the sake of explaining both the invention and the prior art.

[0030] Fig. 2a shows a schematic sectional view through an apparatus of the invention in a first operating state.

[0031] Fig. 2b shows a schematic sectional view through an apparatus of the invention in a second operating state.

[0032] Fig. 3 shows an apparatus according to the prior art.

[0033] Description of the Exemplary Embodiment

[0034] Fig. 1 is a schematic illustration that has already been used above to explain the prior art. The key element of the apparatus is the piston 14, which is disposed between a first region 10 and a second region 12. While in an apparatus of the prior a pressure-holding valve 16 is absolutely necessary, in order to adjust the working pressure in the second region 12 to a usable value, in the apparatus of the invention it is sometimes possible to omit the pressure-holding valve 16. However, under some circumstances an additional regulation of the working pressure in which a leakage quantity is finally diverted in the direction of the fuel tank via the pressure-holding valve 16 can also be useful.

[0035] In Figs. 2a and 2b, pistons 14 for transferring fluid from the first region 10 to the second region 12 are shown in two different operating states. In Fig. 2a, an operating state can be seen in which a comparatively low pressure prevails in the first region 10. In modern common rail systems, the pressure in the first region 10 during the operating state shown can be about 200 bar. The piston 14, which is disposed in a bore 18, is urged by force in the direction of the first region 10 by a spring 20. The bore 18 is divided into two portions. The first portion 22 in cooperation with the piston 14 presents considerably lesser resistance to the fluid than the second portion 24. Or in simpler terms, the second portion 24 is sealing, while the second portion 22 is not sealing. However, both portions 22, 24 serve to guide the piston 14.

[0036] If the pressure in the second region 10 now increases, then sometimes the state shown in Fig. 2b ensues. The piston 14 is driven upward counter to the force of the spring 20, departing entirely or in part from the portion 22 and penetrating the sealing portion 24 entirely or in part. Consequently, a considerably greater resistance is now presented to the fluid. As a result, despite the substantially elevated pressure in the first region 10, in the ideal case the same working pressure is established in the second region 12 as was already present in the situation shown in Fig. 2a.

[0037] The above description of the exemplary embodiments of the present invention is intended solely for purposes of illustration and not for the sake of limiting the invention. Within the scope of the invention, various changes and modifications may be made without departing from the scope of the invention or its equivalents.